Influence of mussel (*Mytilus edulis*) aquaculture on lagoonal sedimentation: Lagoa de Albufeira (Portugal)

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Introduction: The Albufeira lagoon (Portugal), located 20km south of Lisbon, with a superficial area of 1.3km^2, consists of two main water bodies – Lagoa Grande (LG) and Lagoa Pequena (LP) – separated by a narrow channel. The wider and deeper body (LG) supports an industry of mussel farming since the late 1970's. Juvenile "seed" mussels are allowed to grow and reproduce after attachment to 5-6m long ropes hanging from small wooden rafts. When considered mature, they are harvested, rinsed and sold. In 2003 there were 15 registered and licensed rafts (although only few were fully operational), with an estimated production of ~500 ton/year of living mussel. The rafts are anchored, but mooring allows for some tide and wind-generated drift and the surface swept is of ~2000 m^2 [1].

Mussels are suspension-feeding organisms and the undigested remains, ejected by mucus-bound feces and pseudofeces, sink to the water-sediment surface [2], thus increasing natural sedimentation rates and inducing changes in the physical-chemical characteristics of the sediment that can affect the benthic communities beneath culture sites [3].

This study aims at comparing sedimentology and geochemistry of lagoonal bottom sediments accumulated under direct influence (beneath) the aquaculture rafts, versus sediment accumulated nearby but free of their influence, to assess if, and to what extent, intensive mussel farming is eventually modifying the local sedimentary environment.

Methods: This study relies on the sedimentological analysis of 147 sediment samples collected from LG in 11 field surveys between 1990 and 2012 to assess spatial variation in bottom sediments. Complementarily, 8 bottom sediment samples were dredged under the rafts and suspended sediment samples were obtained from a trap moored near-bottom and beneath a raft during one week.

All sediment samples were texturally characterized and classified according to Flemming [4]; organic matter (OM) in sediment was determined by weight-loss on ignition (LOI) at 500ºC during 2h and calcium carbonate determined through a gasometric method using an Eijkelkamp calcimeter. Profiles of ^{210}Pb and ^{137}Cs were used to derive sedimentation rates.

Results & Discussion: The pattern of LG sediment distribution is roughly concentrical, with mud and slightly sandy mud (<25% particles >63μm) high in OM (usually 7-10%, reaching 14%) occupying the central and deeper area; the Ca-carbonate content is typically of 5-10% (reaching 15%) related with diverse bivalve>gastropod shells/shell fragments. In contrast, coarse sediment accumulates in relation with (1) the inlet (OM-free, marine, carbonate-poor (≤5%) quartz sand (>98% particles >63μm), and (2) the shallow marginal areas (terrestrial-sourced sand sorted by local waves to sandy mud, typically <13%-rich in bioclastic Ca-carbonate, occasionally reaching 30% associated with patchy lags of disarticulated *Cerastoderma edule* shells and OM≤7%).

Bottom sediment beneath mussel rafts shows an increase in $CaCO_3$ (17-59%), essentially associated with *Mytilus edulis* valves and shell fragments. Incorporation of this biogenic fraction coarsens most of this sediment (50-75% >63μm) and dilutes the OM in total sample; when determined in material without whole *Mitylus* valves, OM (9-12%) matches the higher values found in the lagoonal bottom sediments away from the aquaculture influence.

Trapped sediment is essentially muddy (>70% particles <63μm) and richer in OM (17-24%) [5]. Preliminary data on mass rate of sediment accumulation in traps indicates 37kg/m^2/year; considering a dry bulk weight of 1ton/m^3, this translates into a sedimentation rate of 3.7cm/year. This figure is about 10x higher than the sedimentation rates determined in LG in the last century (~0.3cm/year).

In conclusion, the most conspicuous sedimentary imprints of mussel aquaculture found in lagoonal bottom sediments is the unique association of high-organic, fine sediment with abundant monospecific, biogenic, coarse particles, with a potential to increase sedimentation rate.

References: [1] Mendes (2003) *ICNB* 77; [2] Newell (2004) *Journal of Shellfish Research* **23**:51-61; [3] Callier (2004) *PhD Thesis*, University of Quebec 248; [4] Flemming (2000) *Continental Shelf Research* **20**:1125-1137; [5] Silva (2006) *MSc thesis*, University of Lisbon 129.